Space Weather Technical Forecast

Issued on Thursday, 10 August 2023 at 13:05 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: S1 Minor solar radiation storm has now waned.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity recorded at GOES16 has been Low over the past 24 hours, with occasional C-class flares observed. These flares peaked with a C5.4 at 10/0242UTC from a plage on the southwestern limb, perhaps containing the faded remnant of Ex-AR3398. The main other noteworthy flare was a C4.0 from AR3394 at 10/0032UTC, with this spot group appearing as a Cso/Beta-Gamma.

There are now up to five surviving sunspot regions on the disc, with three of these small and magnetically unipolar. The most significant groups were both near the central solar meridian - the aforementioned AR3394, which showed some minor small spots come and go in the ambit of the main penumbral spot; and also AR3395 to the north. This group showed greater development in some leading spot proliferation, classed as a Dsi/Beta-Gamma by the period's end.

There were three main noted Coronal Mass Ejection (CME)-generating events in the period. Firstly, a large plume of ejecta was visible well past the western limb around 09/1530UTC on roughly the latitude of Ex-3386, although any attribution is speculative given that it is long past being a front-sided group. This subsequently released a filament-like structure in the following hours that was visible as a dimming that translated from near the solar equator towards the southern crown. This is the reason for the subsequent partial halo signature (mainly south and west) in coronagraphs, and neither the initial CME nor the tied later event are thought to have any Earth-bound component.

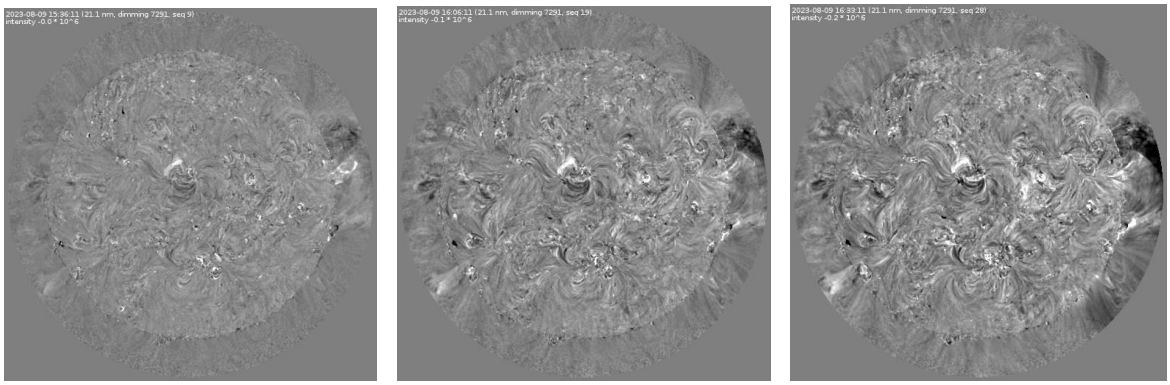

Figure 0: SIDC ROB-generated AIA 211 running difference sequence, showing the narrowly far-sided plasma emission and the subsequent two-stage dimming – initially westward, and then west through southwest. This CME(s) are not Earth-directed.

The second event was tied to the aforementioned peak flare of the 24 hours on the southwestern limb. Modelling has been submitted for this, and although results are not yet

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available, any Earth-directed component appears unlikely.

Thirdly, a large filament gradually released in the far south of the facing side of the disc around 10/0600UTC. This feature is now becoming visible in coronagraphs, although being very low latitude this is tentatively considered likely to miss.

At the time of writing therefore, no Earth-directed CMEs have been identified.

Solar Wind / Geomagnetic Activity: The solar wind, as measured at L1 by ACE and DSCOVR, was mostly reflective of a slow regime, perhaps with a very minor embedded transient (in both duration and magnitude). The source of this is not known, but given its extremely brief tenure, it may be an extreme glance from the trailing edge of a side lobe from one of the mainly west-directed CMEs from the period 04-06 August.

The solar wind speed fell from near 410 to around 360km/s through the period. The solar wind density rose in the first half of the period to become Slightly Elevated, peaking at 15ppcc near 09/1900UTC, before waning back to single figures. This was matched by a minor IMF discontinuity, rising to match an earlier peak of 7nT, but more notably with a visible change in character. The trace became more smooth between 09/2000-10/0400UTC, whereupon the previous more erratic tendencies once again took over. The north-south component was smaller still in magnitude, ranging from -4 to +2nT, although again with the change of character evident between the IMF times stated. The phi angle was negative throughout (towards the Sun), but yet again with a smoother tendency during the advertised times.

The net result of the above solar wind measures was for Quiet geomagnetic conditions throughout, peaking with a provisional Kp 2+ in the 21-24UTC interval.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux showed the ongoing tail of a response to the X1.5 flare peaking at 07/2046UTC from Ex-AR3386 (now long-past the western limb), perhaps with minor re-enhancements from flares from Ex-AR3387 to its immediate east. Having peaked at 47pfu early on 09 August, levels now lie near the 10pfu boundary at the time of writing.

High energy (greater than 2MeV) electron flux at GOES16 showed a slight increase in the last 24 hours, peaking at 1770pfu at 09/1730UTC with a diurnal oscillation between High and Normal Background levels, perhaps slightly influenced (downwards) by the assumed minor transient. The associated 24-hour integrated fluence remained well below the Active level (1e8 integrated pfu), with 4.61e7 integrated pfu recorded at 10/0001UTC with near-level trend.

Four-Day Space Weather Forecast Summary

Solar Activity: Low levels of solar activity are anticipated, with only a Slight Chance of further M-class flares. No significant regions depart in the period, and while there are far-side soundings suggesting arrivals, any assessment as to their potency is withheld until they present for analysis. The flare risk is therefore constant throughout.

Solar Wind / Geomagnetic Activity: No fast winds nor Earth-bound CMEs feature in the forecast, and mainly Quiet conditions should therefore persist throughout.

Energetic Particles / Solar Radiation: The risk of further S1 Minor Solar Radiation Storms should continue to very gradually ease towards the raw value for the front-side over the coming UTC weekend, i.e. a daily Slight Chance. In the interim, risks are maintained higher due to current elevated levels in the near-Earth environment (i.e. requiring little further impetus) and the presence of the historically prolific Ex-AR3386 around 130W.

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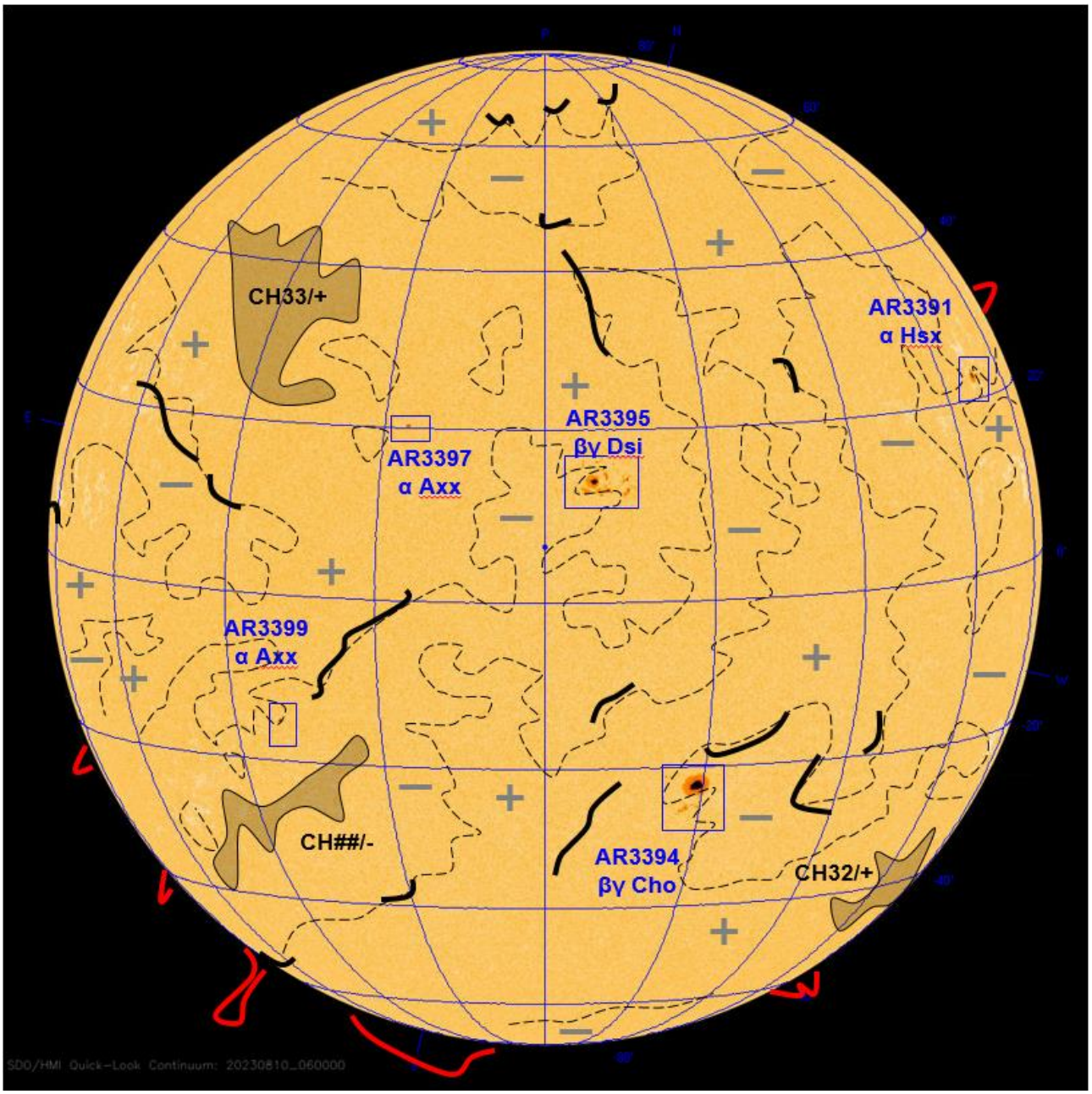
In the absence of any drivers and with the assumption that a steady state is near being achieved, the high energy (greater than 2 MeV) electron fluence carries a now-reduced daily Slight Chance of reaching Active levels, with flux perhaps touching High during diurnal peaks.

Figure 1. Solar Analysis Valid 10/1800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

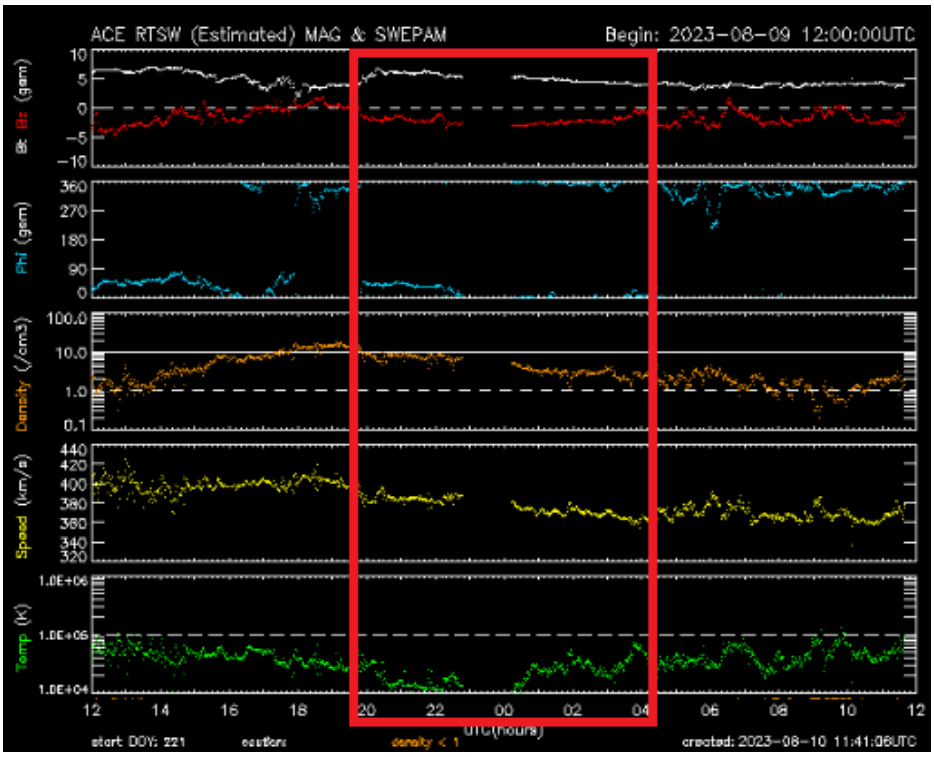
No CMEs feature in the four-day forecast, nor coronal hole fast winds, and the risk of geomagnetic storms is therefore held very low and constant throughout.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: Possible transient in the otherwise slow regime, mainly signalled by smooth changes in behaviour, although this diagnosis is conjectural. The disturbance was not consequential for geomagnetic activity irrespective of the cause.



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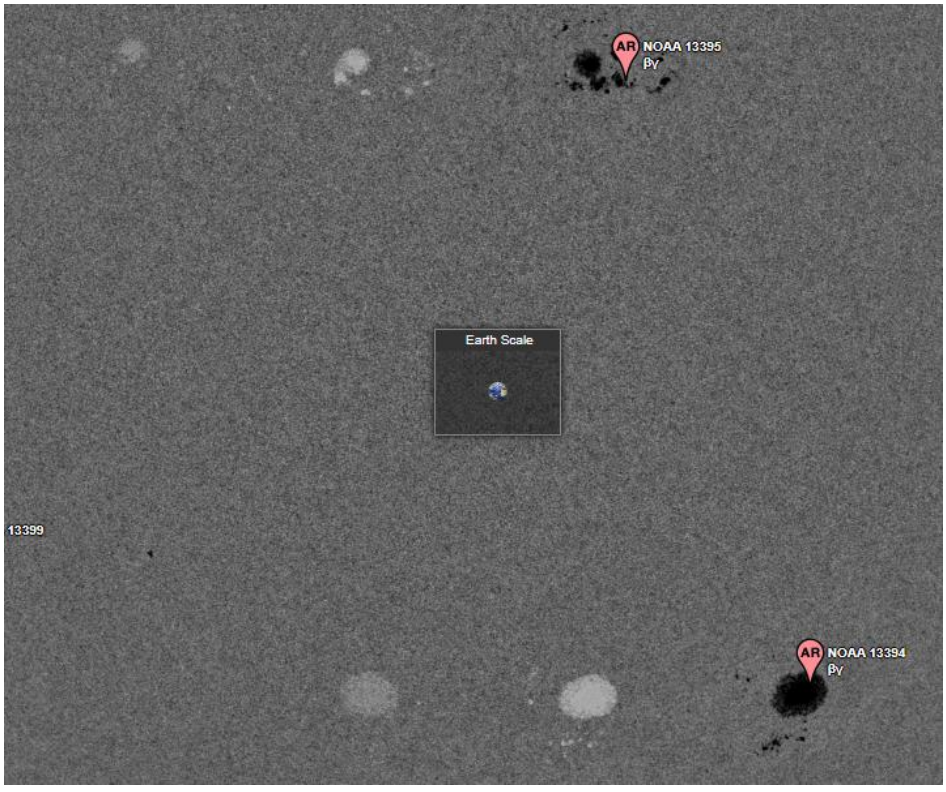
Radio Blackouts - X-Ray Flares:

Most of the current frontside groups are unipolar, and while the two exceptions to this are currently near the meridian and growing, they have yet to produce activity beyond mid C-class. Assuming a continuation of the current state of affairs, no significant groups leave in the period. Far-side soundings do suggest at least some northern hemisphere returning regions are due over the eastern horizon in the coming days, however there are no other aggravating factors (such as recent CMEs or promineces), and any increase in risk is withheld until they present for analysis.

Overall, a flat Slight Chance of M-class activity is maintained for all days.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Helioveiwer.org-generated running difference of HMIIF imagery footprints of the surviving two most complex regions on the disc, with both showing growth in this period. Probably the most complex is now the northern AR3395, although this has yet to see appreciable flare activity as a result. Images on 24 hour cadence ending with 10/1140UTC (black spots)



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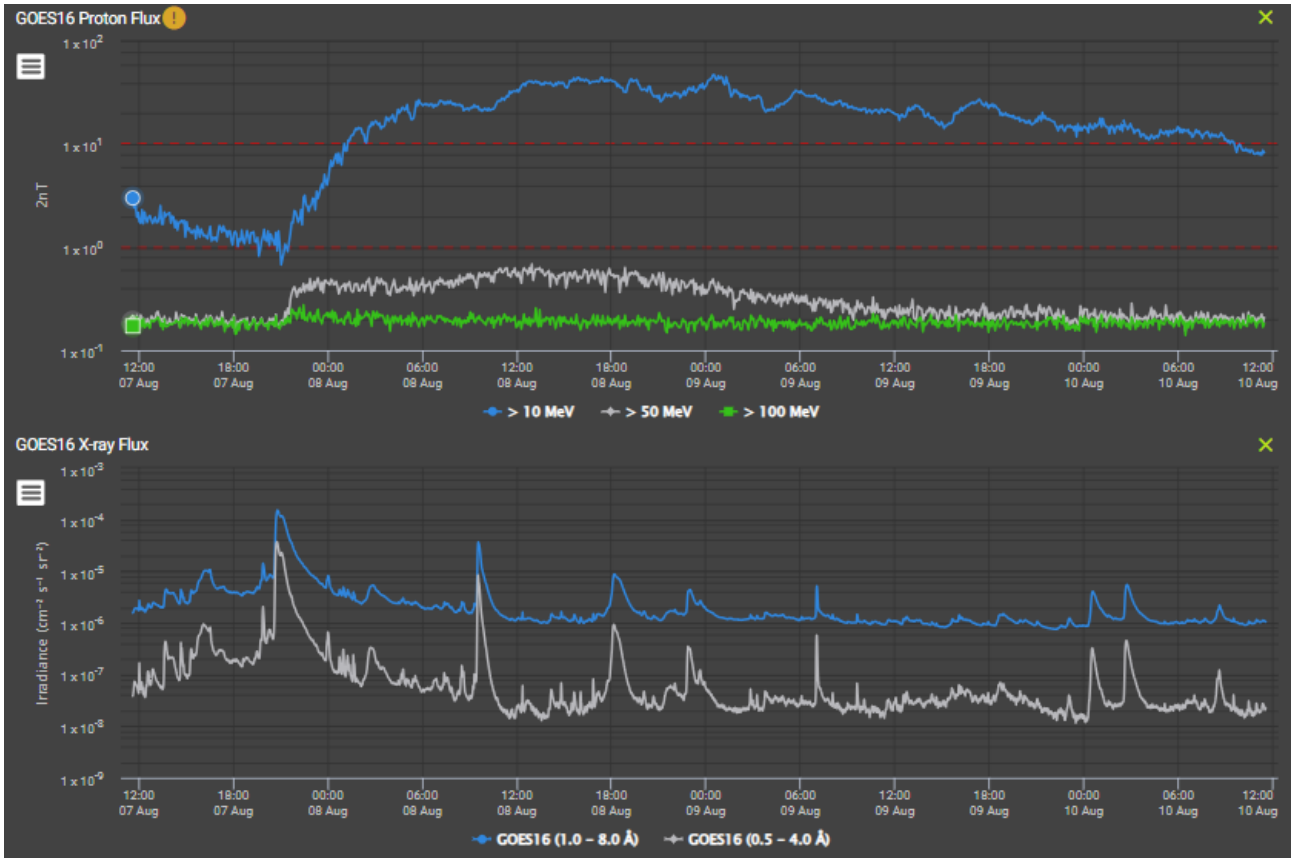
Solar Radiation Storms - (High Energy Protons):

Solar radiation levels have now finally ebbed below the S1 level for 10MeV protons. The sunspot group responsible for their initial enhancement is now long-past the western solar horizon (Ex-Ar3386), as is its contributory trailing region (Ex-AR3387). Although declining, there remains a Chance of further minor exceedences of S1 should large flares occur in either group, however this risk will lessen into the UTC weekend, eventually settling near the raw value for the current facing side.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	Yes	40	20	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Past 72 hours in GOES16 high energy proton flux spectrum (top) and linked GOES16 X-ray flares (bottom). These show a long-lasting 47pfu peak response to the X1.5 flare from Ex-AR3386 late on 07 August. Further such enhancements are now much less likely and fall with time.



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High Energy Electrons Event (≥ 2MeV):

There are now no expected geomagnetic inputs in the forecast (fast wind or CME-related). REFM's current forecast in maintaining fluence levels comfortably below Active is therefore accepted, on the proviso that the current behaviour of electrons at GEO is near a steady state from recent CME disturbances - certainly major rises now appear unlikely, although diurnal High flux is perhaps more realistic.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^{8}$	No	1	10	10	10
Very Active	≥ 2 MeV ≥ $1x10^{9}$	No	1	1	1	1

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